VIDEOS IN CLINICAL MEDICINE
SUMMARY POINTS

Ultrasound-Guided Paracentesis

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The following text summarizes information provided in the video.

OVERVIEW

Abdominal paracentesis can be performed as either a diagnostic or a therapeutic procedure. Diagnostic paracentesis involves the use of fine-needle aspiration to establish the causes of nascent ascites or to rule out infections such as spontaneous bacterial peritonitis.[1] Therapeutic paracentesis involves catheter drainage to alleviate abdominal discomfort or respiratory compromise.[1] The use of ultrasound for guiding paracentesis generally results in fewer complications, including bleeding and bowel injury, and increased operator comfort and procedure success rates.[2-4]

Static ultrasound guidance is used to select and mark the site of needle insertion immediately before the procedure takes place. Dynamic ultrasound guidance, in contrast, is used to directly visualize needle entry into the peritoneal cavity in real time. Dynamic ultrasound guidance requires a higher skill level and should be performed only by those who are fully trained in this technique.[4] This article focuses on static ultrasound guidance.

INDICATIONS FOR PARACENTESIS

Diagnostic paracentesis is indicated when there is a need to elucidate the cause of ascites, to rule out spontaneous or secondary bacterial peritonitis in any patient with ascites and acute decompensation, or to monitor the response to treatment of bacterial peritonitis. Diagnostic paracentesis should be performed as soon as possible in any patient with cirrhosis and ascites presenting for acute clinical care.[5] Therapeutic indications for paracentesis are to relieve pain, discomfort, or dyspnea related to ascites and to treat abdominal compartment syndrome.[5]

CONTRAINDICATIONS TO PARACENTESIS

Paracentesis is contraindicated at sites with overlying infection, visibly enlarged vessels, or abdominal-wall hematoma. It should be avoided in patients who are unable to follow instructions. Pregnancy is a relative contraindication, and only experienced providers should perform this procedure in pregnant patients.

Untreated acute disseminated intravascular coagulation and uremia with thrombocytopenia are also relative contraindications to therapeutic paracentesis.[5,6] In patients with cirrhosis, the presence of thrombocytopenia or an elevated prothrombin time does not accurately predict the risk of bleeding due to the procedure, and transfusion of clotting factors or platelets before the procedure is not routinely recommended.[5,6] Transfusion of blood products can be considered on an individualized basis in these scenarios.[5,6]

The procedure should not be attempted if the amount of ascites is insufficient for safe sampling. The procedure should also not be attempted near abdominal

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structures such as the liver, spleen, bladder, or bowel.[1,4] The presence of abdominal adhesions may also be considered a relative contraindication. Loculated ascites may preclude therapeutic paracentesis.

EQUIPMENT

Gather the necessary equipment, which may be assembled in prepackaged kits. You should be familiar with the equipment and kits available at your institution.

For sterile preparation and administration of analgesia you will need an absorbent underpad, antiseptic solution containing chlorhexidine gluconate (or povidone–iodine or 70% alcohol solution if the patient has an allergy to chlorhexidine), sterile gauze, sterile gloves, a drape, a face mask, eye protection, anesthetic agents such as 1 to 2% lidocaine or 0.25 to 0.5% bupivacaine, and a 5-to-10-ml syringe with small-gauge needles for the administration of anesthetic agents, such as a 22-, 25-, or 27-gauge needle, with sufficient length to anesthetize the peritoneum.[1] To obtain samples of ascitic fluid, you will need an ultrasound device equipped with both a low-frequency and a high-frequency transducer, an over-the-needle catheter device of sufficient length to reach the peritoneum, a large syringe (at least 60 ml in volume) for obtaining the sample, a scalpel, tubes and culture bottles for the samples, vacuum bottles or suction canisters and drainage tubing (if you are performing a large-volume paracentesis), and dressings or bandages.[1]

PATIENT PREPARATION

Obtain written informed consent from the patient or a legal representative. Ask the patient about allergies to latex, chlorhexidine, iodine, or anesthetic agents. If possible, have the patient empty the bladder to minimize the risk of bladder injury.

Position the patient with the head of the bed elevated at approximately 30 to 45 degrees to allow free fluid to collect in the lower quadrants. You may place a pillow underneath the patient's contralateral hip to encourage fluid collection during the procedure.

ULTRASOUND AND SCANNING

A low-frequency phased-array or curvilinear transducer is the optimal transducer for finding intraabdominal free fluid (Fig. 1). Scan the right upper quadrant, left upper quadrant, and pelvic views in both sagittal and transverse planes to ensure that the patient has free fluid and that any fluid seen is not contained within structures. A dilated cecum; cysts within the kidney, liver, or ovaries; hydronephrosis; and an enlarged bladder can give the false appearance of ascites. These fluid collections are generally rounded in appearance.

Figure 1. Use of a Low-Frequency Ultrasound Probe to Identify Ascites.

Next, scan the lower quadrants of the abdomen. Find the best site for paracentesis by identifying key sonographic landmarks, including the subcutaneous tissue, peritoneum, ascites, and abdominal organs (Fig. 2). Ascites appears as a dark, or anechoic, space bound superficially by the abdominal wall and bright, or hyperechoic, peritoneum. The intestines appear as hyperechoic free-floating structures in the deeper image field. Abdominal organs are generally intermediate in their echogenicity.

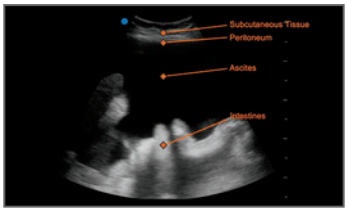

Figure 2. Sonographic Appearance of Ascites and Adjacent Structures.

Use ultrasound to identify the preferred site — one that has the largest amount of fluid, does not have overlying vasculature, and is a sufficient distance away from intraabdominal organs, the bowel, and the inferior epigastric artery and veins. When ascites is identified, note the relative depth of the fluid from the skin as well as the size of the fluid collection from the peritoneum to the intestines to

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guide selection of a needle and catheter of sufficient length. The needle should be inserted along the angle of insonation (the angle of the transducer and beam relative to the skin and subcutaneous tissue). Once you visualize the ascitic fluid, scan in two planes, at least 5 cm in each direction, to ensure that there is no underlying bowel.

Apply gentle downward pressure to mimic the pressure that may be encountered when you insert the catheter. Note the depth of free fluid present with downward pressure. Seek a fluid depth of at least 2 cm to ensure procedural safety. If the bowel is in close proximity to the abdominal wall when pressure is applied, seek an alternative site for the needle insertion. Providers with less experience in performing paracentesis should choose a site that is a distance of 5 cm or more from bowel and other structures in each plane.

Next, use the high-frequency transducer to rule out the presence of overlying vasculature. Locate the inferior epigastric artery and veins in the rectus sheath (Fig. 3), and use those vessels as a reference. Use power or color Doppler imaging and place the transducer in a transverse orientation to the rectus sheath in the pelvis, adjusting the color box to cover the area from the skin to the peritoneum. Adjust the machine settings to detect low flow. Hold the transducer still. When you use color Doppler imaging, you may need to tilt the transducer slightly to detect flow, which may be missed if the transducer is placed perpendicular to the vessel. Adjust color gain to detect any underlying vessels. First increase the gain, then decrease the gain slowly until any signal noise disappears. Once the vessels are clearly visible, move the transducer and use the same settings to scan the chosen paracentesis site in multiple planes. If you detect vessels, choose an alternative site. Ensure that the selected site is located at least 2 cm lateral to the rectus sheath in the right or left lower quadrant to avoid puncturing the inferior epigastric vessels.

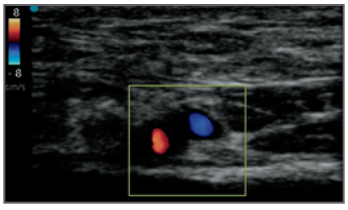

Figure 3. Use of Doppler Imaging to Identify Vasculature.

Mark the intended site with a surgical marking pen or apply gentle sustained downward pressure with the end of a needle cap to mark the site. Wipe off the gel and instruct the patient to remain still after the site has been marked. If a high-frequency transducer is not available, an assessment for vessels can be performed with a low-frequency transducer, although the sensitivity for identifying vessels may be lower.

PARACENTESIS

Before beginning the procedure, perform a procedural timeout to confirm the correct patient, procedure, and site of needle insertion. Confirm the amount of fluid to be removed, and prepare to perform an albumin infusion and diagnostic testing as indicated. Obtain a baseline set of vital signs. Perform hand hygiene before opening and preparing the kit, and prepare the site of needle insertion with an appropriate antiseptic solution.

Don personal protective equipment, including a mask, eye protection, and sterile gloves. A sterile gown is optional. Place the fenestrated sterile drape over the intended needle insertion site. Ensure that you have a sufficient sterile field to perform the procedure.

Draw up 5 to 10 ml of local anesthetic. Using a small-gauge needle such as a 22-, 25-, or 27-gauge needle, raise a wheal under the skin, then direct the needle deeper, aspirating while advancing to ensure that the needle is not in a blood vessel before local anesthetic is injected. A slightly longer and larger-gauge needle such as a 22-gauge needle may be needed to infiltrate the deeper tissues all the way to the peritoneum. When the fluid is aspirated in the catheter, inject an additional few

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milliliters of anesthetic solution into the highly sensitive peritoneum and withdraw the needle. For patients with considerable adipose tissue or anasarca, a lumbar puncture needle with the stylet removed may be necessary.

After ensuring that the skin is well anesthetized, make a small incision of less than 5 mm across in the skin with a scalpel to facilitate catheter insertion. Adjust the length of the inserted blade so that the incision will be just large enough for the catheter to pass through; the incision should never exceed the depth from the skin to the peritoneum noted on the ultrasound. For scalpels with adjustable lengths, adjust the blade length so that the incision will be less than 5 mm across. This small incision minimizes the pressure needed to advance the catheter into the peritoneum. Excessive pressure may decrease the space between the peritoneum and the bowel and may increase the risk of complications. Using the catheter over-the-needle complex attached to a syringe, insert the needle while applying negative pressure on the syringe.

Once you encounter ascitic fluid, advance the needle another 1 to 2 mm to ensure that the catheter is fully introduced into the peritoneum. Holding the syringe steady, advance the catheter fully over the needle into the peritoneal cavity (Fig. 4). Withdraw the needle once the catheter is fully advanced. Never reinsert the needle into the catheter after the needle has been retracted because this could lead to catheter fragmentation within the peritoneum.

Figure 4. Catheter Insertion for Paracentesis.

Obtain culture samples and any other necessary specimens using a sterile syringe. Place the ascitic fluid samples into the appropriate specimen bottles, including direct inoculation into culture bottles using sterile transfer devices, and submit them to the laboratory for testing.

If therapeutic paracentesis is indicated, connect the tubing to the vacuum bottles or to the suction canister. Some kits contain equipment to allow for manual drainage of fluid to a bag.

TROUBLESHOOTING

If the flow of ascites slows or stops during fluid sample collection, consider the following steps. If you are using a vacuum container, close the stopcock, if present, or clamp the tubing and replace it with a syringe. If you can aspirate fluid with a syringe, then it is likely that the vacuum device and its connections are the problem. Focus on those to ensure that suction is present. If you cannot aspirate fluid with a syringe, reposition the patient without contaminating the field by elevating the head of the bed or by slowly turning the patient toward the side of the paracentesis. If flow remains limited, close the stopcock connected to the patient or clamp the tubing, and then gently rotate and slightly withdraw the catheter and reconnect the suction apparatus. An additional troubleshooting technique includes flushing the catheter with sterile saline, which may dislodge any bowel tissue that might be blocking the catheter ports. The procedure should be terminated if these maneuvers do not improve the flow of fluid or if there is difficulty aspirating the fluid.

If substantial postprocedural leakage of ascites from the original catheter-insertion site occurs, turn the patient to the side opposite the insertion site, which facilitates the internal flow of ascites away from the site; use adhesive glue or a purse-string stitch to close the incision; or use an oxidized regenerated cellulose patch on the incision followed by adhesive glue. Although the use of the "Z-line technique" for catheter insertion can be considered to avoid the occurrence of postprocedural ascites leakage,[1] this technique may increase the risk of bleeding

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due to inadvertent vessel puncture unless it is performed with real-time ultrasound guidance. The Z-line technique is performed by pulling cutaneous tissues caudally before needle insertion to minimize the overlap of the insertion site at the skin with the peritoneal insertion site.[1] For patients in whom the volume of ascites detected is small, consider referral to an experienced proceduralist who is comfortable with dynamic ultrasound guidance.

PROCEDURE COMPLETION

When the sample collection is complete, withdraw the catheter and apply gentle pressure followed by a bandage. Dispose of sharps, fluid, and equipment appropriately.

Consider use of intravenous albumin infusion in instances of large-volume paracentesis. Monitor the patient for any postprocedural complications.

COMPLICATIONS

The overall risk of the procedure is low. However, always monitor the patient for postprocedural ascites leakage; clinically significant bleeding, which could lead to hemoperitoneum or abdominal-wall hematoma, hypotension or shock, or even death, especially if the inferior epigastric artery is lacerated; infections, ranging from a localized skin infection to peritonitis or bloodstream infection; catheter-tip fragmentation, the risk of which is minimized by never reinserting the needle into the catheter; organ injury; hepatorenal syndrome and acute kidney injury, especially when large-volume paracentesis is performed without albumin replacement; and adverse reactions to the local anesthetic agent.

SUMMARY

Paracentesis can be safely performed at the bedside with ultrasound guidance for diagnostic and therapeutic indications.

Disclosure forms provided by the authors are available with the full text of this article at NEJM.org.

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